

WHAT IS CLAIMED IS:

1                   1.       An optical signal converter for converting signals at one frequency to  
2 signals at another frequency within a frequency grid, each adjacent pair of frequencies in said  
3 frequency grid separated by a predetermined amount, said optical signal converter comprising  
4                   a difference frequency generator receiving an energizing pump signal and an  
5 input signal at a first frequency and generating a converted signal at a second frequency from  
6 said input signal and said pump signal, said pump signal at a frequency such that said first  
7 and second frequencies are separated by an odd multiple of said predetermined amount; and  
8                   a separator having an input port and at least one output port, said input port  
9 connected to said difference frequency generator, said separator responsive to said odd  
10 multiple passing said converted signal to said at least one output port so that said converted  
11 signal is separated from said input signal.

1                   2.       The optical signal converter of claim 1 wherein one-half of said pump  
2 frequency is between two frequencies of said frequency grid.

3                   3.       The optical signal converter of claim 1 wherein said one-half of said  
4 pump frequency is one-half between said two frequencies.

5                   3.1 The optical signal converter of claim 1 wherein said one-half of said  
6 pump frequency is one-quarter between said two frequencies.

1                   4.       The optical signal converter of claim 1 wherein said separator  
2 comprises a WDM interleaver device.

1                   5.       The optical signal converter of claim 1 wherein said separator has a  
2 second output port, said separator responsive to said odd multiple passing any input signals to  
3 said second output port.

1                   6.       The optical signal converter of claim 1 wherein said multiple state  
2 separator comprises an optical interferometric device.

1                   7.       The optical signal converter of claim 6 wherein said optical  
2 interferometric device comprises a Mach-Zehnder interferometer.

1                   8.       The optical signal converter of claim 6 wherein said optical  
2 interferometric device comprises an array waveguide grating.

1                   9.     The optical signal converter of claim 6 wherein said optical  
2 interferometric device comprises a Fabry-Perot interferometer..

1                   10.    The optical signal converter of claim 6 wherein said optical  
2 interferometric device comprises a crystal-based Fourier filter device.

1                   11.    The optical signal converter of claim 1 wherein said difference  
2 frequency generator receives a plurality of input signal at a plurality of first frequencies and  
3 generating a plurality of converted signals at a plurality of second frequencies from said input  
4 signal and said pump signal, said pump signal at a frequency such that said pluralities of first  
5 and second frequencies are separated by an odd multiple of said predetermined amount; and  
6 wherein said separator responsive to said odd multiple passes said plurality of converted  
7 signals to a first output port and passes any input signals to a second output port so that said  
8 converted signals are separated from said input signals.

1                   12.    The optical signal converter of claim 1 wherein said difference  
2 frequency generator receives a plurality of energizing pump signals and generating a plurality  
3 of converted signals at a plurality of second frequencies from said input signal, said pump  
4 signals at frequencies such that said first and second frequencies are separated by odd  
5 multiples of said predetermined amount; and wherein said separator responsive to said odd  
6 multiples passes said plurality of converted signals to a first output port and passes any input  
7 signals to a second output port so that said converted signals are separated from said input  
8 signals.

1                   13.    An optical signal converter for converting a plurality of input signals at  
2 a plurality of first frequencies to a plurality of signals at a plurality of second frequencies,  
3 said first and second frequencies within a frequency grid, each adjacent pair of frequencies in  
4 said frequency grid separated by a predetermined amount, said optical signal converter  
5 comprising

6                   a separator having an input port and a plurality of output ports, said separator  
7 receiving said input signals at said input port and passing said input signals to said output  
8 ports according to locations of said first frequencies of said input signals in said frequency  
9 grid;

10                  a plurality of difference frequency generators, each difference frequency  
11 generator connected to an output port of said first separator and receiving an energizing pump

12 signal and at least one input signal at one of said first frequencies and generating a converted  
13 signal at one of said second frequencies from said input signal and said pump signal, said  
14 pump signal at a frequency such that said one of said first frequencies and said one of said  
15 second frequencies are separated by an odd multiple of said predetermined amount; and  
16 a combiner having a plurality of input ports and an output port, each input port  
17 connected to one of said difference frequency generators, said combiner responsive to said  
18 odd multiple to pass said converted signal from each difference frequency generator to said  
19 output port and to reject any input signals so that said converted signal is separated from said  
20 input signal from each difference frequency generator at said output port.

1 14. The optical signal converter of claim 13 wherein said input signals are  
2 at said input port of said separator simultaneously.

1 15. The optical signal converter of claim 13 wherein said input signals are  
2 at said input port of said separator sequentially.

1 16. The optical signal converter of claim 13 wherein first frequencies of  
2 said input signals are located by multiples of said predetermined amount from an arbitrary  
3 reference frequency in said frequency grid and said separator passes said input signals to said  
4 output ports according to the evenness or oddness of said multiples.

1 17. The optical signal converter of claim 16 wherein each difference  
2 frequency generator converts said at least one input signal to a signal at one of said second  
3 frequencies of opposite evenness or oddness of said multiple of said one of said first  
4 frequencies of said at least one input signal.

1 18. The optical signal converter of claim 17 wherein said combiner  
2 comprises a device the same as said separator except having a reverse connection.

1 19. An optical signal converter for converting a plurality of input signals at  
2 a plurality of first frequencies to a plurality of signals at a plurality of second frequencies,  
3 said first and second frequencies within a frequency grid, each adjacent pair of frequencies in  
4 said frequency grid separated by a predetermined amount, said optical signal converter  
5 comprising

6 a first separator having an input port and a plurality of output ports, said first  
7 separator receiving said input signals at said input port and passing said input signals to said

8 output ports according to locations of said first frequencies of said input signals in said  
9 frequency grid;

10 a plurality of difference frequency generators, each difference frequency  
11 generator connected to an output port of said first separator and receiving an energizing pump  
12 signal and at least one input signal at one of said first frequencies and generating a converted  
13 signal at one of said second frequencies from said input signal and said pump signal, said  
14 pump signal at a frequency such that said one of said first frequencies and said one of said  
15 second frequencies are separated by an odd multiple of said predetermined amount;

16 a plurality of second separators, each second separator having an input port  
17 and at least one output port, said input port connected to one of said difference frequency  
18 generators, said second separator responsive to said odd multiple to pass said converted  
19 signal to said at least one output port so that said converted signal is separated from said input  
20 signal at said output port; and

21 a combiner having a plurality of input ports and an output port, each input port  
22 connected to one of said at least one output ports of said difference frequency generators, said  
23 combiner passing said converted signals at said plurality of input ports to said output port.

1 20. The optical signal converter of claim 19 wherein said input signals are  
2 at said input port of said first separator simultaneously.

1 21. The optical signal converter of claim 19 wherein said input signals are  
2 at said input port of said first separator sequentially.

1 22. The optical signal converter of claim 19 wherein first frequencies of  
2 said input signals are located by multiples of said predetermined amount from an arbitrary  
3 reference frequency in said frequency grid and said separator passes said input signals to said  
4 output ports according to the evenness or oddness of said multiples.

1 23. The optical signal converter of claim 22 wherein each difference  
2 frequency generator converts said at least one input signal to a signal at one of said second  
3 frequencies of opposite evenness or oddness of said multiple of said one of said first  
4 frequencies of said at least one input signal.

1 24. The optical signal converter of claim 19 wherein said combiner  
2 comprises a device the same as said first separator except having a reverse connection.  
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5 25. An optical signal converter for converting signals at one frequency to signals at another  
6 frequency within a frequency grid, each adjacent pair of frequencies in said frequency grid  
7 separated by a predetermined amount, said optical signal converter comprising  
8 a difference frequency generator receiving an energizing pump signal and an  
9 input signal at a first frequency and generating a converted signal at a second frequency from  
10 said input signal and said pump signal, wherein one-half of said pump frequency is between  
11 two frequencies of said frequency grid.

12 ~~26~~<sup>26</sup> 26. The optical signal converter of claim 26 wherein said one-half of said pump  
13 frequency is one-quarter between said two frequencies of said frequency grid.

14 ~~28~~<sup>28</sup> 28. The optical signal converter of claim 25 including a separator, said separator having at  
15 least one input port and at least one output port, said input port connected to said difference  
16 frequency generator,

17 ~~29~~<sup>29</sup> 29. The optical signal converter of claim 28 wherein said separator is responsive to an  
18 odd multiple of one half of said predetermined amount of said frequency grid so that said  
19 converted signal is separated from said input signal.

20 ~~30~~<sup>30</sup> 30. The optical signal converter of claim 25 wherein said converted signal is shifted from  
21 said frequency grid by one half of said predetermined amount.

22 ~~31~~<sup>31</sup> 31. The optical signal converter of claim 28 wherein said separator comprises a WDM  
23 interleaver device.

24 ~~32~~<sup>32</sup> 32. The optical signal converter of claim 25 including a combiner having at least one  
25 input port and at least one output port, said input port connected to said difference frequency  
26 generator, said combiner passing said converted signal at said input port to said output port.

27 ~~33~~<sup>33</sup> 33. The optical signal converter of claim 32 wherein said combiner is responsive to an  
28 odd multiple of one half of said predetermined amount of said frequency grid so that said  
29 converted signal is separated from said input signal.

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31 ~~34~~<sup>34</sup> 34. The optical signal converter of claim 32 wherein said combiner comprises a WDM  
32 interleaver device.

33 ~~35~~<sup>35</sup> 35. The optical signal converter of claim 28 wherein said separator comprises an optical  
34 interferometric device.

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36 ~~35~~ The optical signal converter of claim 35 wherein said optical interferometric  
37 device comprises a Mach-Zehnder interferometer.

1 ~~36~~ The optical signal converter of claim 35 wherein said optical interferometric  
2 device comprises an array waveguide grating.

1 ~~37~~ The optical signal converter of claim 35 wherein said optical interferometric  
2 device comprises a Fabry-Perot interferometer.

1 ~~38~~ The optical signal converter of claim 35 wherein said optical interferometric  
2 device comprises a crystal-based Fourier filter device.

3 ~~39~~ The optical signal converter of claim 32 wherein said combiner comprises an optical  
4 interferometric device.

5 ~~40~~ The optical signal converter of claim 40 wherein said optical interferometric  
6 device comprises a Mach-Zehnder interferometer.

1 ~~41~~ The optical signal converter of claim 40 wherein said optical interferometric  
2 device comprises an array waveguide grating.

1 ~~42~~ The optical signal converter of claim 40 wherein said optical interferometric  
2 device comprises a Fabry-Perot interferometer.

1 ~~43~~ The optical signal converter of claim 40 wherein said optical interferometric  
2 device comprises a crystal-based Fourier filter device.

3 ~~44~~ 45. An optical signal converter and combiner for converting signals at first set of  
4 frequencies located on a first frequency grid to signals at a second set of frequencies located  
5 on a second frequency grid, each adjacent pair of frequencies in said first frequency grid and  
6 said second frequency grid separated by a predetermined amount, and said second frequency  
7 grid shifted from said first frequency grid by one half of said predetermined amount, said  
8 optical signal converter and combiner comprising  
9 a difference frequency generator receiving an energizing pump signal and a  
10 first input signal at said first set of frequencies and generating a converted signal at said  
11 second set of frequencies from said first input signal and said pump signal, wherein one-half  
12 of said pump frequency is one-quarter between two frequencies of said first frequency grid;  
13 and

14 a combiner having a plurality of input ports and at least one output port,  
15 wherein a first input port is connected to said difference frequency generator, said combiner  
16 passing said second set of frequencies at said first input port to said output port.

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18 ~~46~~ The optical signal converter and combiner of claim 45 including  
19 a third signal at a third set of frequencies on said first frequency grid;

20 wherein said third set of frequencies are connected to a second input port of said combiner;  
21 wherein said third set of frequencies is combined with said second set of frequencies at said  
22 output port of said combiner.

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